DC Output Power Supply Calculations Summary

(jas, DC Output Power Supply Calculations Summary.docx, 12/13/2024)

For this portion of the DC Output Power Supply Project, complete your calculations for R5, I_{calc}, R_{bias2}, I_{bias2} for V_{in} = 21 V, R1, R_f, I_{R1}, C_f and Input Ripple Voltage V_R for $I_{Load} = 0.9I_{calc}$. Then replace the blue text in **Table 1** with your values, which should be within the ranges given. Please reference the document "DC Output Power Supply Project.docx" for details on how to perform the following calculations. Utilize standard 5% resistor values and standard 10% capacitor values for all calculated resistor and capacitor values. Standard 5% resistors and 10% capacitor values are as follows:

- Standard 5% resistor values are limited to the following numerical values per decade of resistor values: 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82 and 91. For example, 1.0 Ω, 10 Ω, 100 Ω, 1.0 kΩ, 10 kΩ, 100 kΩ, etc., are standard 5% values.

- Standard 10% capacitor values are limited to the following numerical values per decade of capacitor values: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, and 82.

Include your calculations below for the following component values for your DC Output Power Supply: R5 and I_{calc}, R_{bias2} and I_{Rbias2} for V_{in} = 21 V, R1, R_f and I_{R1}, C_f and Input Voltage Ripple V_R for $I_{Load} = 0.9I_{calc}$. Points will be deducted for missing calculations.

62.5 ˚C/W thermal resistance
50 ˚C ambient temperature
175 ˚C maximum operating junction temperature
V_R5 = 0.66 V
V_ Diode = 0.7 V

R5 and I_{calc}

$$I_{calc} = \frac{\left(\frac{T_J - T_A}{R_{\theta JA}}\right)}{V_{DS}} = \frac{\left(\frac{175℃ - 50℃}{62.5℃/W}\right)}{20.3V - (9V + 0.66V)} = 188\ mA$$

$$R_5 = \frac{V_{R5}}{I_{calc}} = \frac{0.66V}{188mA} = 3.51\ \Omega \approx 3.6\ \Omega$$

$$I_{calc\_actual} = \frac{V_{R5}}{R_{5\_actual}} = \frac{0.66V}{3.6\Omega} = 183\ mA$$

R_{bias2} and I_{bias2} for V_{in} = 21 V

$$R_{bias2\_min} = \frac{V_{in\_max} - 2.5V}{I_{bias2\_max}} = \frac{20.3V - 2.5V}{1mA} = 17.8\ k\Omega$$

$$R_{bias2\_max} = \frac{V_{in\_min} - 2.5V}{I_{bias2\_min}} = \frac{11.3V - 2.5V}{0.1mA} = 88\ k\Omega$$

$$R_{bias2} = 24\ k\Omega$$

$$I_{bias2} = \frac{20.3V - 2.5V}{24k\Omega} = 742\ uA$$

R1, R_f and I_{R1}

$$R_1 = 24\ k\Omega$$

$$I_{R1} = \frac{2.5V}{24k\Omega} = 0.104\ mA$$

$$R_f = \frac{9V - 2.5V}{I_{R1}} = 62.4\ k\Omega\ \approx 62\ k\Omega$$

C_f and Input Ripple Voltage V_R for $I_{Load} = 0.9I_{calc}$

$$C_f = \frac{I_{load}}{f_R V_R} = \frac{0.9(0.183A)}{(60Hz * 2)1V} = 1375\ uF \approx \boxed{1000\ uF}$$

$$V_{R\_actual} = \frac{0.9(0.183A)}{(60Hz * 2)1000uF} = \boxed{1.38\ V}$$

After performing the calculations, check your values by downloading and running the calcCheck_Student.m MATLAB script. This can be done using a downloaded version of MATLAB on your desktop/laptop or using MATLAB Online. The MATLAB file calcCheck_Student.m provides a quick check of your calculations and chosen values prior to soldering components onto the PCB. To utilize this MATLAB script, first run the script and then when prompted in the Command Window enter your values for V_{out}, R5, R_{bias2}, R1, R_f and C_f followed by Enter. The MATLAB script then provides feedback information for you in the Command Window.

Replace the Ranges of Values in the Table below with your values including units.

Table 1: Power Supply Design Chosen and Calculated Values.

V_{out}	9.0 V
R5	3.6 Ω
I_{calc}	183 mA
R_{bias2} for $V_{in} = 21$ V	24 kΩ
I_{Rbias2} for $V_{in} = 21$ V	742 uA
R1	24 kΩ
R_f	62 kΩ
I_{R1}	0.104 mA
C_f	1000 μF
Input Ripple Voltage V_R for $I_{Load} = 0.9I_{calc}$.	1.38 V pk-pk